Chapter 14
Biofiltration (Vapor)

14-1. General

The process of biofiltration and its applications are described in the chapter's first section. The second portion is a hazard analysis with controls and control points listed.

14-2. Technology Description

a. Process.

Biofiltration uses biodegradation to treat air stream contaminants (volatile organic compounds [VOCs]) prior to releasing the stream to the atmosphere. It can be viewed as a self-renewing adsorption bed. The VOC-laden vapor is passed over a porous bed of high surface area packing that serves both as a support surface for the appropriate microbes and as an adsorbent surface for the VOC. This increases the retention time of the VOC in the bed and permits the microbes more time to degrade organic compounds. The air contaminants are solubilized and in turn are degraded by the microbes. Materials that can serve as packing include sand, activated carbon, ceramic supports, peat moss, wood chips, and glass and plastic beads. As this is a destructive process, the unit operating cost is usually less than adsorbent regeneration processes such as activated carbon. Nutrients and water may be added by spraying across the top surface of the bed. If water is not added, the entering air stream must be humidified to prevent the bed from drying out (which will inhibit microbial activity). Specifically, cultured organisms may be used in an effort to shorten the acclimation time at the start of operations. The biofiltration process is illustrated in Figure 14-1.

b. Applications.

The technology is best suited to steady-flow streams where the VOC composition and concentration changes slowly if at all. The bed will generally not keep the exhaust air stream in compliance during periods of shock loading as the microbes require time to grow and adapt to different concentrations of substrate.

Vapor biofiltration has been successfully used for odor control in the food industry (bakeries and breweries), for solvent vapor treatment from fiber glassing and painting operations, and for the treatment of SVE exhaust streams prior to atmospheric release.

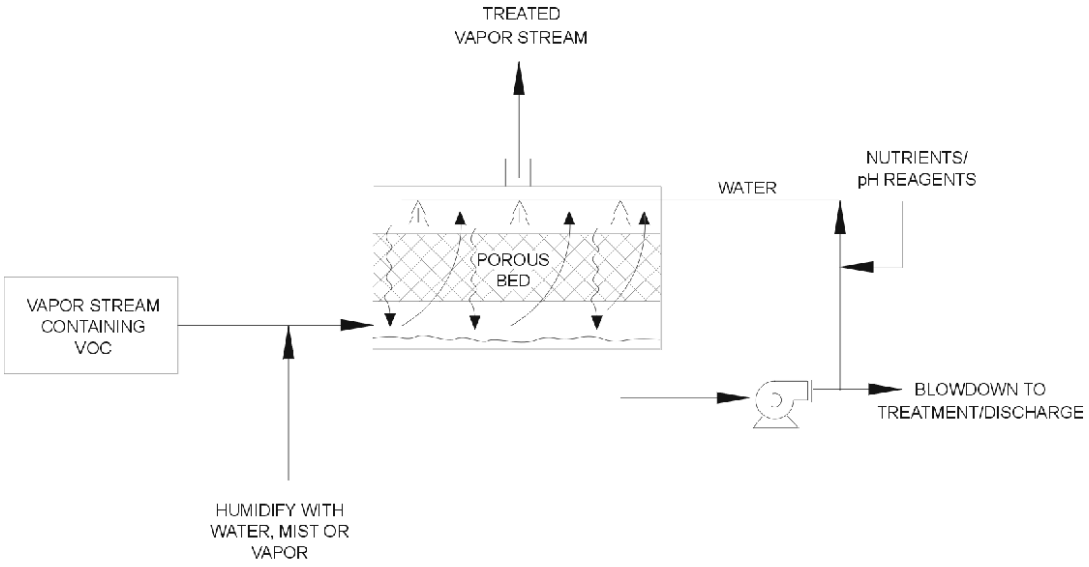

FIGURE 14-1. TYPICAL PROCESS FLOW FOR BIOFILTRATION (VAPOR)

14-3. Hazard Analysis

Principal unique hazards associated with vapor biofiltration, methods for control, and control points are described below.

a. Physical Hazards.

(1) Confined Space.

Description. Entering process vessels and tanks to inspect and maintain them is a permit-required confined-space entry. Associated hazards include asphyxiation from the lack of oxygen, overexposure to toxic wastes and byproducts, and engulfment or entrapment by the filtration media.

Control. Controls for confined-space entry include:

- Train operators and workers in confined space hazards and in safety procedures to be employed when entering confined spaces.
- Design the biofiltration and reaction vessels to maximize easy operation, physical cleaning, and maintenance, to include accessible, adequately sized access doors or entry ports, and to minimize the frequency, duration, and extent of cleaning and maintenance required.
- Develop a pre-entry confined space permit. Implement a confined space entry program to access hazards, including atmospheric testing inside the tanks. Use confined-space entry procedures for any entry activities (see 29 CFR 1910.146).

- Provide ventilation of the vessel interior prior to and during the confined space entry to eliminate the oxygen-deficient or toxic atmosphere.
- Wear appropriate personal protective equipment (PPE), including respiratory protection (e.g., an air-purifying respirator with organic vapor cartridges) or supplied air, as needed.
- Use the Buddy System for such operations.

CONTROL POINT: Operations, Maintenance

(2) Electrocution.

Description. Workers may be exposed to electrical hazards when working around biofilters. If permanent and temporary electrical equipment that is not ground-fault protected contacts water or other liquids, an electrocution hazard exists.

Control. Controls for electrocution include:

- Verify that drawings indicate the hazardous area classifications as defined in NFPA 70, Chapter 5, sections 500.1 through 500.10.
- Use controls, wiring, and equipment that meet the requirements of EM 385-1-1, Section 11.G, and NFPA 70 for the identified hazard areas.
- Perform all electrical work according to code and under the supervision of a state licensed master electrician.
- Use grounded or GFCI-protected equipment if required by EM 385-1-1, Section 11, or NFPA 70.
- Permit only trained, experienced workers in equipment areas.

CONTROL POINT: Design, Construction, Operations, Maintenance

(3) Treatment Buildings.

Description. Permanent or semi-permanent treatment buildings may present life safety hazards, such as inadequate egress, fire suppression systems, or emergency lighting systems, or walkways without fall protection.

Control: Controls for treatment buildings include:

- Meet the following construction requirements for permanent and semi-permanent treatment system buildings: ANSI 58.1: “Minimum Design Loads for Buildings and Other Structures,” the “National Fire Code,” the “National Standard Plumbing Code,” “Life Safety Code,” and the “Uniform Building Code.”
- Comply with either the Air Force Manuals on Air Force bases, the USACE Technical Manuals on Army installations, or local building codes on Superfund, Base Realignment and Closure (BRAC) or Formerly Used Defense Sites (FUDS) project sites.

CONTROL POINT: Design, Operations

(4) *Emergency Wash Equipment.*

Description. Emergency shower/eye wash equipment required per 29 CFR 1910.151 is not always provided with adequate floor drains, thereby creating potential electrical hazards and walking surface hazards during required testing and use.

Control. A control for emergency wash equipment includes:

- See American National Standards Institute ANSI Z 358.1 – 1998: "Emergency Eyewash and Shower Equipment" for design requirements.
- Equip showers/eye wash equipment with accompanying functional drains to isolate and collect the shower/eye washwater from unprotected electrical equipment and walking surfaces that, when wet, create slipping and electrical hazards.

(5) Design Field Activities.

Description. Design field activities associated with subsequent construction may include surveying, biological surveys, soil gas surveys, geophysical surveys, trenching, drilling, stockpiling, contaminated groundwater sampling, and other activities. Each of these field activities may expose the survey personnel to physical, chemical, radiological, and biological hazards.

Control. Controls for hazards resulting from predesign field activities include:

- Prepare an activity hazard analysis for predesign field survey activities. EM 385-1-1, Section 1, provides guidance on developing an activity hazard analysis.
- Train workers in hazards identified.

CONTROL POINT: Design

b. Chemical Hazards.

(1) Additives.

Description. Biological activity of the biofilters may be enhanced with the addition of nutrients or other chemical agents. These agents may include nutrients (e.g., ammonia nitrate, urea) or other chemicals (e.g., hydrochloric acid, sodium bicarbonate). Workers may be exposed to these chemicals during their application. Overexposure symptoms may include eye, skin, and respiratory tract irritation.

Control. Controls for additives include:

- Consult chemical manufacturers' Material Safety Data Sheets (MSDS) for potential hazard information and controls, including appropriate personal protective equipment (PPE), and train workers accordingly.
- Use recommended PPE (e.g., an air-purifying respirator with organic vapor cartridges) during the application or blending processes.
- Design mechanical addition systems to minimize exposure.

CONTROL POINT: Design, Operations, Maintenance

(2) Fire or Explosion.

Description. Storage of the materials may cause fire or explosion if they are spilled and allowed to mingle with incompatible chemicals.

Control. Controls for fire or explosion include:

- Store incompatible materials separately or in secondary containment.
- Train operators in chemical hazards and potential reactions, and in storing, handling, and transferring the materials and chemicals.
- Train the operators in emergency procedures in case of a catastrophic event, in life saving first aid procedures including halting and neutralizing chemical reactions, extracting, decontaminating and stabilizing victims, and in emergency storage area isolation and shutdown procedures.
- Locate, and maintain emergency eyewashes and showers at critical locations in the area. (See ANSI Z358.1 – 1998)
- Consult the manufacturer or the Material Safety Data Sheets for incompatibilities.

CONTROL POINT: Design, Operations, Maintenance

c. Radiological Hazards.

No unique hazards are identified.

d. Biological Hazards.

(1) Opportunistic Insects and Animals.

Description. For all sites but especially in cooler climates, opportunistic insects or animals can nest in and around warm process equipment. Vermin, insect, and arthropod control measures should be considered in any design.

Control. Control of opportunistic insect and animals include:

- Electrical cabinets and other infrequently opened enclosures should be opened carefully and checked for black widow and brown recluse spiders, and evidence of rodents. As rodents can cause damage to electrical cables, all wiring should be inspected regularly.

- Ensure all storage is off the ground, palleted, and kept dry. Damp areas attract scorpions, rodents, and the snakes that eat them.
- Design ceiling corners and other high areas to discourage nesting by swallows, pigeons, and other birds. Birds are carriers of diseases, especially in their droppings, which can foul cranes and process equipment.

CONTROL POINT: Design, Operations and Maintenance

(2) Pathogenic Microbes.

Description. Biofilters can expose workers to pathogenic microbes, especially during maintenance activities where the reactor may need disassembly or when workers are required to enter the biofiltration vessels. Inhalation of pathogenic microbes, such as legionella bacteria, can cause allergic reactions or illness. During support media handling activities, workers' hands can be exposed to the microbes and result in accidental ingestion of pathogenic material.

Control. Controls for pathogenic microbes include:

- Install partitions or barriers to contain the mist.
- Test or monitor for suspect microbes such as legionella.
- Use N, R or P100 or N, R or P95 particulate filter air-purifying respirators approved for microbial inhalation hazards.
- Minimize skin exposure with PPE such as gloves (e.g., butyl rubber) and chemically resistant disposable coveralls.
- Practice good decontamination by thoroughly washing hands and face before exiting the work area.

CONTROL POINT: Design, Maintenance